What Does Climate Change Mean for the Arctic?
How is Alaska Being Affected?

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How is Alaska Being Affected?**

March 15, 2005

PANELISTS

Dr. Robert Corell, Chair, Arctic Climate Impact Assessment (ACIA) and Senior Policy Fellow at the American Meteorological Society

Dr. Pal Prestrud, Vice Chair, ACIA and Director of the Center for International Climate and Environmental Research in Oslo

Dr. Heidi Cullen, Climate Expert with the Weather Channel and former scientist with the National Center for Atmospheric Research

The Environmental and Energy Study Institute (EESI) held a Congressional briefing on March 15, 2005 on the Arctic Climate Impact Assessment (ACIA) [1] and climate change impacts already observed in Alaska. The assessment, released in November 2004, is an intergovernmental report based on a four-year scientific study of the Arctic conducted by an international team of 300 scientists and sponsored by the eight arctic nations (Canada, Denmark, Finland, Iceland, Norway, Russia, Sweden and the United States) and six indigenous people's organizations. It concludes that the average winter temperatures in Alaska and other arctic regions have increased by 4 to 7°F (3-4°C) in the past 50 years, twice the rate of the rest of the globe, and are projected to continue rising for the next century. Alaska is being affected by climate change and experienced its warmest summer on record in 2004, characterized by its worst fire season, unprecedented insect outbreaks, and significant coastal erosion. The warming has caused a decline in summer sea ice extent and thickness, allowing seasonal storms to increasingly erode portions of the Alaskan coastline. The Government Accountability Office (GAO) estimates costs of $100-400 million to move a single endangered Alaskan village, with some 184 villages seen as susceptible to flooding and erosion. [2]

> **"The Arctic is now experiencing some of the most rapid and severe climate change on Earth. Over the next 100 years, climate change is expected to accelerate, contributing to major physical, ecological, social, and economic changes, many of which have already begun."**
>
> ***Dr. Robert Corell***

SECTION I: Arctic Warming is a Preview of the Consequences of Climate Change

Global trends and patterns in temperature and precipitation indicate a shift in recent years from average climate trends and patterns. Over the last 125 years, the ten warmest years globally (with respect to the 1880-2003 mean) have occurred during the last decade or so. Dr. Robert Corell, Chair of the Arctic Climate Impact Assessment team and Senior Policy Fellow at the American Meteorological Society, stressed that 2004 was the warmest year on record for northern hemisphere oceans. The ACIA used computer models and field tests to show that heat and energy levels in areas as deep as nearly a half-mile in some oceans have risen dramatically in the past 40 years in direct conjunction with rising levels of carbon dioxide (CO2) and other greenhouse gases (GHGs). The authors concluded that they "have discovered the first clear evidence of human-produced warming in the world's oceans." According to Dr. Corell, 90 percent of the heat that is above the global mean goes into the ocean while just over three percent heats the atmosphere. The rest melts land and sea ice. Dr. Corell said, "The ocean really is the flywheel that determines the timing and magnitude of change across the planet."

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Box 1: Key Findings from the Arctic Climate Impact Assessment

- Annual average arctic temperature has increased at twice the rate of global temperatures over the past several decades, with some regions up 5-10 times the global average.
- In Alaska and western Canada, the average winter temperatures have increased by as much as 3-4˚C over the past 60 years, which is a significant increase given that the global average increase over the past 100 years has been about 0.6±0.2°C.
- Five state-of-the-art computer models used in ACIA, regardless of the emissions scenario or computer model selected, project significant warming for the Arctic over the next 100 years. The models suggest a warming across the Arctic that is 2-3 times that of the global increases projected by the Intergovernmental Panel on Climate Change (IPCC), with Arctic surface air temperate increasing by 3.5-6°C by 2100. The projected warming is about 8-10°C for Alaska and about 4-6°C for Greenland by 2100.
- This temperature increase will likely lead to sea level rise reflecting the high end of IPCC estimates, up to 90 cm (3 ft) during this century from a combination of glacial melt and thermal expansion of the oceans.
- Additional evidence of arctic warming comes from widespread melting of glaciers and sea ice, and a shortening of snow seasons.
- Shorter and warmer winters, decreases in ice cover, increasing precipitation in some regions and substantial decreases in snow in other regions are among the projected changes that are very likely to persist for centuries.

The briefing also revealed new data that climate scientists uncovered after the release of the ACIA that illustrates arctic climate warming is occurring even more rapidly than ACIA found. Dr. Corell presented the latest observations showing Alaska's 2004 June-July-August mean temperature to be nearly 5 °F (2.8 °C) above the 1971-2000 historic mean. (See Figure 1.) "Glaciers are another

"The key finding is that the Arctic is warming now and happening very rapidly, and much larger changes are projected." ***Dr. Robert Corell***

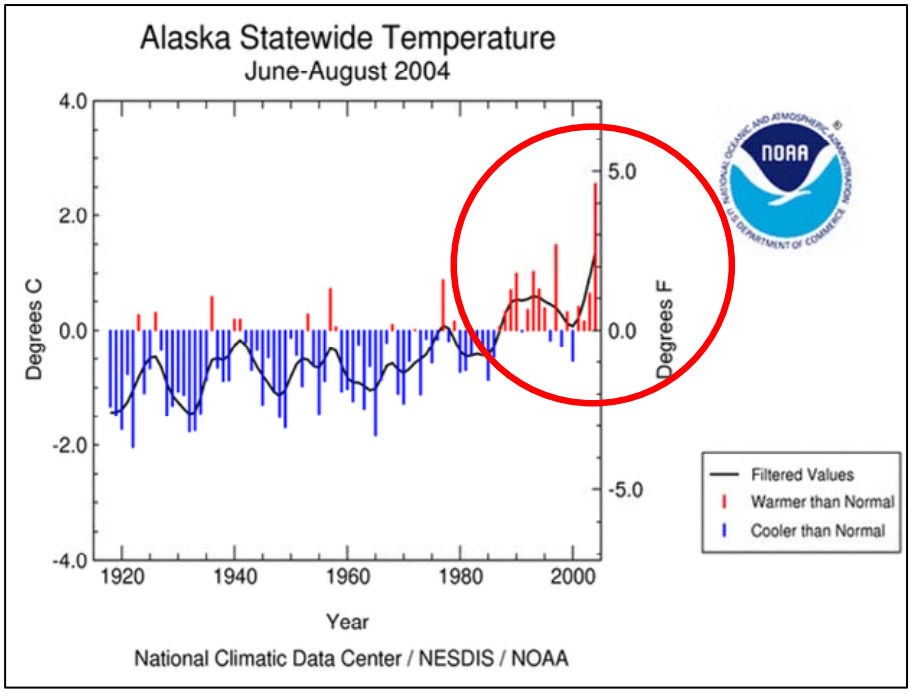

Figure 1. Alaska summer temperature anomalies have increased to 5°F over the mean summer temperature for June-July-August, 2004 with respect to 1971-2000 base period.

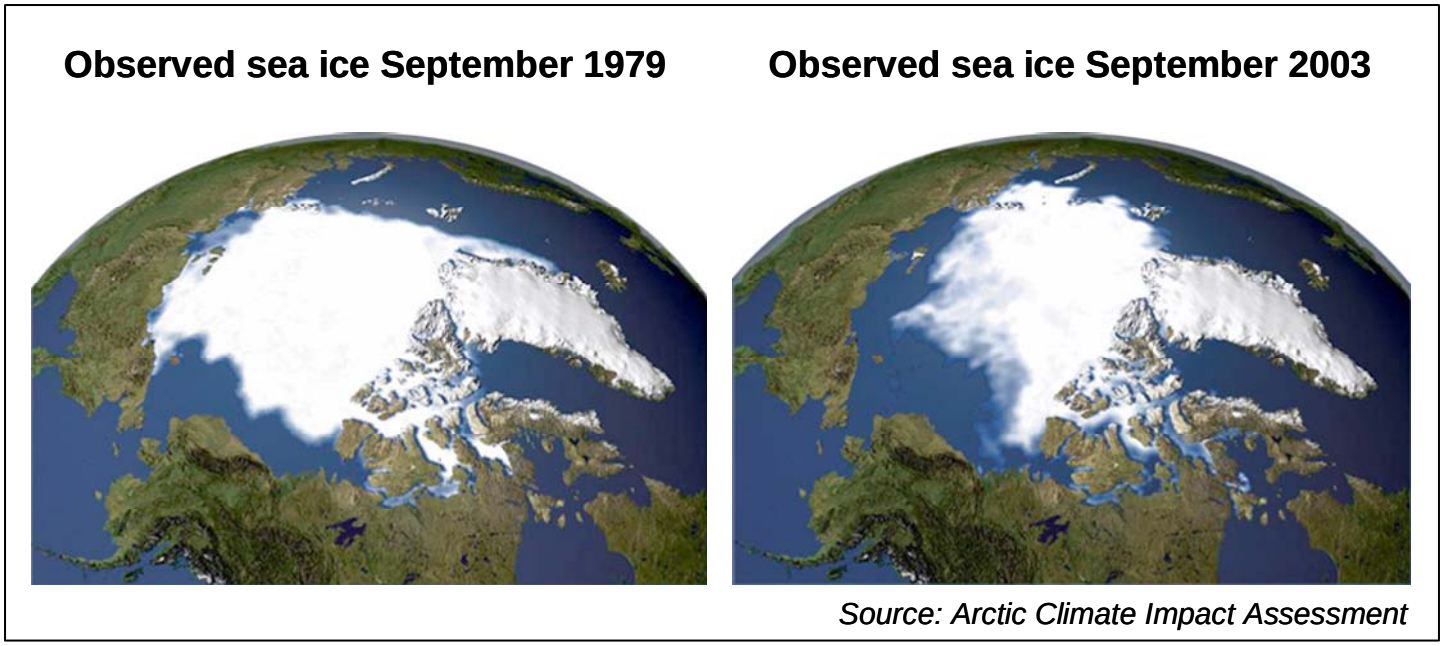

Figure 2. Observed Arctic sea ice decreased 20 percent from September 1979-2003

indicator of change," stated Dr. Corell. The Greenland ice sheet is melting more rapidly than was thought even five years ago. It is projected that if Greenland experiences a 3°C increase in temperature, it will be completely melted in the next thousand years. In addition to glacial melt, the increasing temperatures have caused arctic sea ice to decrease in both extent and thickness. From 1979 to 2003, the extent of arctic sea ice has decreased 10 percent in the winter and 20 percent in the summer. (See Figure 2—1979 is the first year from which aerial photos of the Arctic are available for comparison). Sea ice in the entire Arctic basin has thinned by 18 percent, and in the central Arctic basin by 40 percent, over the last 20 years. Dr. Corell said that by the end of the century there will be very little summer sea ice left. Finally, increasing temperatures are causing permafrost to melt, with rapid changes in mean annual ground temperature being recorded.

> **"This is the consensus of the scientific community, that these things are happening, in the sense that the Arctic is where the action is on many of these issues."** ***Dr. Robert Corell***

As discussed in more detail below, increasing coastal erosion is putting many coastal communities at risk. Dr. Corell said that the worst storms come in the early spring and late fall when the soil is frozen and therefore can protect the coast from erosion. However, a combination of reduced sea ice, which used to buffer the coast from seasonal storms, and soil that is now thawed during these seasons is allowing significant coastal erosion to occur.

With temperature increase and a changing climate, species diversity, ranges and distributions will change. Species ranges are projected to shift northward on both land and sea, bringing new species into the Arctic while severely limiting the domain of some species currently present. **The long-term survival of polar bears is at risk from the melting of sea ice because they hunt seals off the ice.** Reductions in sea ice will drastically shrink marine habitat for polar bears, ice-inhabiting seals and some seabirds, pushing several species toward extinction. As new species move in, animal diseases that can be transmitted to humans, such as West Nile Virus, are likely to pose health risks in areas where they would not previously have been able to spread. The warming is also allowing vegetation lines to shift northward, creating a very different structure for the high north arctic ecosystem. According to Dr. Corell, within ten years, the tree line has been drastically moved northward.

Dr. Corell states that these changes will have ecological, social, and economic effects, with sea level rise, changes in circulation, and opening of seaways that have both "geophysical implications and geopolitical implications" for the rest of the world. The Arctic gives us a preview of the changes that can and will occur around the globe; within just thirty years, more of these changes will be seen elsewhere.

SECTION II: Climate Change in the Arctic Holds Both Global and Political Consequences

Dr. Pål Prestrud, Vice-Chair of ACIA and Director of the Center for International Climate and Environmental Research (CICERO) in Oslo, Norway, said the Arctic Climate Impact Assessment received much more political and media attention than expected because the message of ACIA is clear, easy to communicate, and built on hard scientific facts. Dr. Prestrud explained that the assessment produced a scientific document, a synthesis document and a policy document, and was both a political and scientific process. He detailed the arduous task of coming to agreement on the policy document in the face of US concerns. The outcome of the deliberations on the policy document was the **Reykjavik Declaration**—a stand-alone policy document accepted at the Fourth Arctic Council Ministerial Meeting on November 24, 2004. Regarding the declaration, Dr. Prestrud said, "It is the best policy document we could have expected when we started; even with the international political situation on climate change issues..... We came a good step further ahead."

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Within this declaration, there are opportunities for Europe to connect its recommendations to international negotiations under the United Nations Framework Convention on Climate Change (UNFCCC), and for the United States to develop initiatives for the private sector and technology development. Dr. Prestrud said there are benefits of the "cap-and-trade" system within Europe to meet the terms of the Kyoto Protocol to the UNFCCC that might also help the United States decrease global carbon emissions. He noted the United States has twice the CO2 emissions per capita of Western Europe, a problem that needs to be addressed. Box 2 lists some of the key points from the Reykjavik Declaration.

Areas of potential global significance discussed by Dr. Prestrud included the effect of the Arctic ice-land-water reflectivity feedback on the global climate system; the large amount of terrestrial carbon stored in arctic tundra, woodlands and forests that could be released into the atmosphere by increasing Arctic temperatures; the potential slowdown of the thermohaline circulation from glacial melt; and implications of increased access to the Arctic as sea ice decreases in extent.

While the Arctic is warming much faster than the global average, climate models project that the northern hemisphere in general will experience the greatest warming compared to the southern hemisphere due to a positive feedback on the climate system between the surface reflectivity of the Earth and incoming solar radiation. Snow, which is highly reflective, reflects 85-90 percent of the sun's radiation. Put another way, snow absorbs 10-15 percent of incoming radiation. By contrast, land vegetation and dark soil absorb roughly 80 percent of incoming radiation, and ocean waters absorb roughly 90 percent of incoming radiation. However, as land-based snow and sea ice melt and decrease in area, greater areas of dark ground, vegetation and ocean waters are exposed to absorb more of the radiation. This effect reinforces itself—a positive feedback. As more solar energy is captured by land and ocean, even more snow and ice will melt.

> **"Timely, measured and concerted action is needed to address global emissions of greenhouse gases"**
>
> ***Dr. Pål Prestrud***

BOX 2: Key Points from the Reykjavik Declaration

- "Recognize that the arctic climate is a critical component of the global climate system with worldwide implications."
- "Acknowledges the need to consider the findings of the ACIA and other relevant studies in implementing their commitments under the UNFCCC and other agreements, including through adoption of climate change mitigation strategies across relevant sectors, and outreach."
- "Endorses the ACIA policy recommendations for mitigation, adaptation, research, monitoring and outreach."
- "To address the risks associated with climate change in the Arctic of the magnitude projected by the ACIA and other relevant studies, timely, measured and concerted action is needed to address global emissions."
- "The scenarios used by the ACIA and elsewhere project that some climate change is inevitable, indicating that continued adaptation is needed."

According to Dr. Prestrud, soil and vegetation in arctic and alpine tundra permafrost and Boreal woodlands and forests holds approximately 25 percent of global terrestrial carbon (an estimated 461 of 1702 billion tons of carbon). This carbon is released as CO2 and methane when permafrost melts, but may be sequestered by expanding vegetation. Therefore, the net effect on terrestrial GHG emissions is unknown.

Climate models indicate that glacial melt will freshen arctic waters, slowing the global ocean current circulation (thermohaline circulation, or THC), and in particular the North Atlantic current. Scientists believe changes in ocean currents can bring abrupt changes in the variability of temperature, have found increases of about 8-10°C within a few decades due to natural variability over the past 100,000 years. Dr. Prestrud said it would be very hard for people in the North to adapt to these changes.

> **"Without US participation in the climate regime, there is little hope of attaining global emissions reductions that can make a difference."**
>
> ***Dr. Pål Prestrud***

While natural climate changes have occurred in the past, Dr. Prestrud explained that these past changes have shown rapid temperature increase and decrease, unlike the slow gradual increase in global temperatures that are projected over the next century by climate models. (See Figure 3.) This is because the climate models are not able to account for unknown non-linear responses in the climate system. This is cause for concern because the climate change happening today is not naturally occurring but influenced by human actions over a very short time scale, in geologic terms; and the linear nature of the models may underestimate actual future climate response to these actions.

A consequence of the disappearing ice in the Arctic is the increase in accessibility to the arctic natural resources. It is believed that 25 percent of world's oil reserves lie in the Arctic. Dr. Prestrud said this would create both environmental and political challenges, including jurisdictional challenges, in terms of who owns these resources. These tensions are becoming more of a reality as warming rapidly increases in the Arctic.

Dr. Prestrud said, "…technology is extremely important to solve the problem" of climate change. The problem with CO2 emissions is not just the current warming effect, for even if we stopped all CO2 emissions now, stabilization of atmospheric CO2 concentration will require several hundred years; and sea-level rise would continue for several millennia due to thermal expansion and glacial melt.[3] Dr. Prestrud concluded by saying "If you realize that you have real problems with the climate in 30-40 years, it is too late to do something about it because these gases we are releasing now will be there for several hundred years."

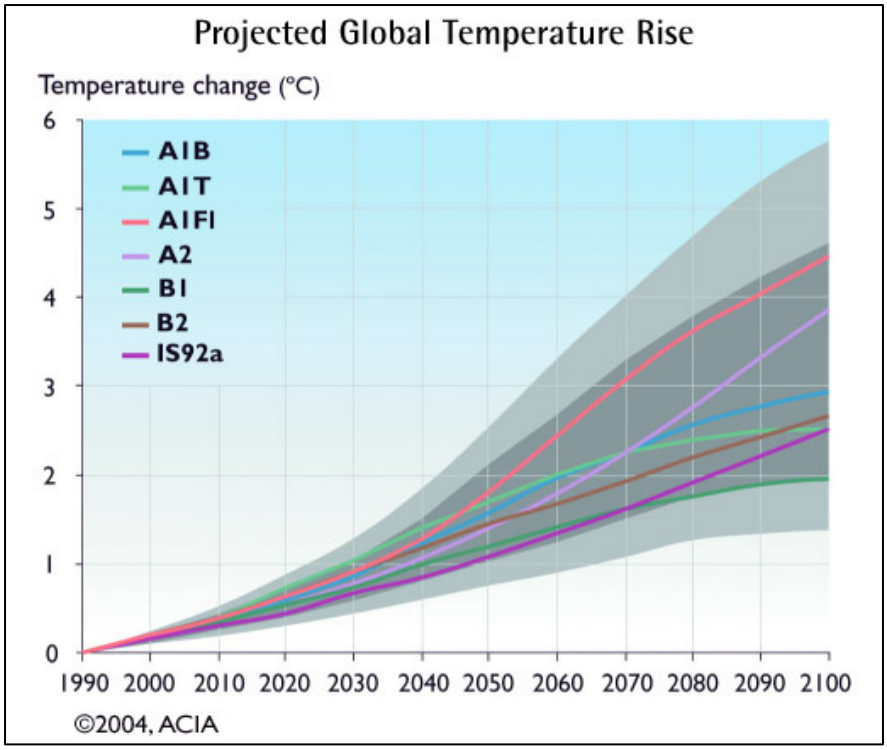

Figure 3. Global temperature rise projected by different climate models and CO2 emissions projections for 1990-2100 from the 2000 IPCC *Special Report on Emissions Scenarios* (SRES). The dark gray band illustrates the range of results for all scenarios with one average model, the light gray band shows the full range of results for all IPCC climate models.

SECTION III: Consequences of Climate Change for Alaskan Communities

Dr. Heidi Cullen, Climate Expert with the Weather Channel and former scientist with the National Center for Atmospheric Research (NCAR), said that the average winter temperature in Alaska has increased more than 6°F since 1948. She illustrated the effect climate change is already having on native Alaskans: increased coastal erosion with loss of village homes and buildings, damage to buildings and roads by melting permafrost, negative effects on indigenous people's hunting by diminished sea ice, and devastation of large areas of Alaska's forests by normally cold-sensitive spruce bark beetles. These effects were captured on Dr. Cullen's five-part video documentary, aired on the Weather Channel, which featured interviews with native Alaskans on climate change who say, "the weather has become a stranger to them."

> **"Alaska's average winter temperature has increased by 6.4°F (3.6°C) since 1948..... enough to thaw permafrost and melt sea ice at the shoreline."**
>
> ***Dr. Heidi Cullen***

Dr. Cullen said the media has put a great deal of energy into refuting climate science, and this requires climate scientists to keep repeating the extensive data and analysis supporting the scientific consensus on climate change. While there will continue to be some uncertainties in climate modeling and climate response, the bottom line is that much of the science of climate change is solid. This is why the media needs to move on to more complex issues within the debate instead of trying to work through the idea, "does this problem exist?" When Dr. Cullen asked people who live in Alaska and the arctic region if the Earth is warming, they shared how it is affecting their lives in a variety of ways—effects that are a preview of what could happen in the lower 48 states sooner rather than later.

Alaska's average winter temperature has increased by 6.4°F since 1948, and this holds many different consequences to the way of life in this region. Overall, Dr. Cullen stated that the Alaskan "culture is tied to the weather," and these communities need to know if and when the weather is shifting. Dr. Cullen said these changes do not merely affect plant and animal life but human life as well. Alaska is 85 percent permafrost, and because most of the permafrost is now just barely frozen, the melting of this solid layer affects housing, oil drilling, and every way of life for Alaskans. With melting permafrost, people's houses are starting to sink, buildings are cracking, supports for the Trans-Alaska Pipeline System are beginning to sink, and coastal erosion is increasing dramatically. (See Figure 4 next page.) The permafrost has been the glue which has held the soil of much of Alaska's coastline together for many years. Now that the glue is gone, Alaskan communities must leave as well, with whole villages needing to move inland at great cost.

> **"Alaska's climate is changing, and that is forcing its people to change with it"**
>
> ***Dr. Heidi Cullen***

Another change exists for those who live on the ice. They see first-hand the impacts of climate change. A change of only a few degrees is highly significant to these people because it is the difference between solid or melting ice. Dr. Cullen stated that within the last 30 years, there has been 10 percent shrinkage of permanent arctic sea ice. This has tremendous impacts on whaling and hunting livelihoods in these Arctic communities. For indigenous people who use the ice as a platform from which the hunting occurs, this tradition and act of survival is being threatened. The melting ice is dangerous and life-threatening. Many people have already fallen through the ice while hunting on what was previously solid footing.

The warming Arctic affects flora and fauna as well as people. For example, Dr. Cullen said longer and warmer summers have increased the spruce bark beetle population and its ability to mature within one year instead of two, allowing them to feed on trees at increasing rates. In the last 15 years, these beetles killed 40 million spruce trees in Alaska, more trees than any other insect has

Figure 4. The village of Shishmaref, located on an island just off the coast of northern Alaska and inhabited for 4000 years, is now facing the prospect of evacuation from coastal erosion. ***Source: ACIA***

killed in North American history—devastating an area two times the size of Yellowstone National Park. The changed lifecycle of this small beetle has had a drastic and tragic effect on the Alaskan landscape.

In conclusion, Dr. Cullen said it is clear the globe is warming and that people make decisions all the time in the face of uncertainties. When talking to businesses, Dr. Cullen says that they understand the scientific data and are considering acting now on climate change. These businesses have found that using energy efficiency to reduce GHG emissions makes good business sense and can improve the bottom line. A number of private sector companies are taking action in this regard. [4]

CONCLUSION

Publication of the Arctic Climate Impact Assessment is a significant milestone in understanding climate change and its effects on the Arctic. ACIA clearly shows that climate change is happening here and now, and that Alaskans, other Arctic peoples, and the geography and ecosystems on which they depend for their livelihoods and culture are fundamentally changing, likely in an irreversible way. Since EESI's briefing, new evidence has been published by Dr. James Hansen, director of NASA's Goddard Institute for Space Studies, confirming through satellite and ocean buoy data that the Earth is now absorbing 0.85±0.15 watts per square meter (W/m^2) more energy from the Sun than it is emitting to space. This implies an additional 0.6°C of global warming is "in the pipeline" already. [5] The message to policymakers was clear—that rapid change is already underway in the Arctic, which in turn will require policymakers to act rapidly to effectively address this pressing issue.

ENDNOTES

[1] ACIA. *Impact of a Warming Arctic: Arctic Climate Impact Assessment*. Cambridge University Press. November, 2004. www.acia.uaf.edu

[2] US Government Accountability Office. *Alaska Native Villages: Villages Affected by Flooding and Erosion Have Difficulty Qualifying for Federal Assistance*. GAO-04-895T. June 29, 2004. http://www.gao.gov/new.items/d04895t.pdf

[3] For further discussion, see the EESI briefing summary, "*Climate Change Post-2100: What are the Implications of Continued Greenhouse Gas Buildup?*" available at http://www.eesi.org/publications/Briefing%20Summaries/9.21.04%20Post-2100%20Climate.pdf

[4] For examples of private sector actions to address climate change, see the EESI briefing, *"Perspectives on Climate Change: Business Initiatives to Reduce Greenhouse Gas Emissions*." November 18, 2004. Speaker presentations available at

http://www.eesi.org/briefings/2004/Energy%20&%20Climate/11.18.04%20Business%20GHG%20Initiatives/announcement.htm

[5] Dr. James Hansen *et. al*. *Earth's Energy Imbalance: Confirmation and Implications*. *Science* 308. April, 2005. http://pubs.giss.nasa.gov/abstracts/2005/HansenNazarenkoR.html

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